International Journal of Applied Engineering
Research and Development (IJAERD)
ISSN(P): 2250-1584; ISSN(E): 2278-9383
Vol. 7, Issue 2, Mar 2017, 1-8

TRANS STELLAR
•Journal Publications •Research Consultancy

COST ESTIMATION AND BUDGET PLANNING ACCURACY LEVEL OF REHABILITATION AND IRRIGATION NETWORK IMPROVEMENT PROJECT USING COST SIGNIFICANT MODEL

HAFNIDAR A. RANI

Civil Engineering Department, Engineering Faculty, Muhammadiyah AcehUniversity

Muhammadiyah Street, Bathoh, Lueng Bata, Banda Aceh, Aceh, Indonesia

ABSTRACT

Rehabilitation and Irrigation network improvement project activities is one of the budget codes containing inBudget Implementation List (DIPA) of Irrigation Institution in South East Districtusing unit price contract. Budget planning in the project is always set based on the experiences without using special method. So that it is required the certain method to find out the works affected in the project and existing budget planning accuracy level to reduce raising cost from the pre construction calculation using estimation price (HPS) before the project is tendered. The objective of this study is to identify the works that significantly affect the total project cost and to get cost model and project accuracy by using CSM Method.The result of this study shows that the stone masonry work (X4) is the most afected work to the budget planning in rehabilitation and Irrigation network improvement project as 74.90% to the works total cost. With the cost estimation accuracy level using Cost Significant Model is around (-11.72%) to31.31%, and accuracy level average is7.18%; the difference between CSM and HPS actual cost is Rp. 633,566,690 (1.07%) or CSM is bigger that HPS actual cost with the accuraci level is 6.92%.

KEYWORDS : Cost Estimation, Accuracy Level, Project Budget Planning & Cost Significant Model

Received: Jan 30, 2017; **Accepted:** Mar 16, 2017; **Published:** Mar 20, 2017; **Paper Id.:** IJAERDAPR20171

Original Article

INTRODUCTION

Budget planning is an important activity to ensure the organization in an institution runs well in carrying out the infrastructure activities in an area. Budget planned amount is often constrained because of the lack information provided in budget preparation period in the next budget yearfor the same work type every year.

To make it easier in predicting the project cost quickly, easily and enough good accuracy level, it is required a method such as Cost Significant Model (CSM). This method can be used eventhough the unit price, specification and description of the project design have not be available yet. This study conducted inRehabilitation and Irrigation NetworkImprovementProjectof Irrigation Institution in South East Districtin the Period 2011 to 2014 with the irrigation networks classifications are semi technical irrigation and simple irrigation.

STUDY LITERATURE

Project Cost Management: According to *Project Management Institute* (2008), project cost management including the process involved in estimating, budgeting and controlling the cost so that the project can be completed in the approved budget period.

Construction Project Cost Component: According to Istimawan (1996), total project cost in construction project activity is total of the cost component includings:labour cost, material cost, equipment cost, indirect cost, andprofit.

Cost Significant Model Method*:* According toPemayun (2003) inIndrawan (2011) stated that The Cost Significant Modelis one of the forecasting methods or total cost predictions of the project based on past cost historic data and relying on the most significant cost that is affected the total project cost as prediction base (estimation).

To estimate the cost of the work, According toPohandHorner (1995), can be carried out by relying on the good documented findings which is from 80% of total project cost value, there is 20% of the project items that have the most expensive cost or the most significant to the total project cost. These cost significant items can present the appropriate proporsionof the total budget cost which is usually close to 80%. Total project cost can be usually calculated by multiplying the total cost of the important cost packages with the right factor, andit is close to 1,25. These value are varied depending on category and data historic analysis.Cost Significant Model can be used to estimate the better cost of 5%and the final calculation is better that 1%. The accuracy can be increased or decreased by repairing the model and depending on data available.

Future Value Factor (Projection Value Factor): *Future value factor effect can be calculated because of the decresing of the money as the caused of inflation factor every year in the related area*. The calculation using Future Value Factor (FVF) can be showed by the below formula (Ostwald, 2001):

$$F = P(1+i)^{n} \quad (1)$$

Description :

F = price value on determined projection year;

P = price before projection;

i =inflation factor in study area;

n = projection year.

Cost Significant Items: Cost Significant Itemsis obtained from the proportion of each work cost component (independent variable) to work total cost (dependent variable). Cost significant itemsare identified as the biggest items percentages that amount are equal or bigger than 80% (≥ 80%) of the total cost.

Model Testing. To get Estimated Bill Value or Cost Significant Model project cost estimation is by multiplying model products of the regression model resultswith the stone masonry and then dividing to the average CMF, as the following equation:

$$Ev = \frac{(Mb \times V_{Pb})}{CMF\text{rata}-\text{rata}} \quad (2)$$

Description :

Ev = *Estimated Bill Value* (CSM project cost estimation);

Mb = Product cost model of multiple linear regression model;

Vpb = Reviewed parameter volume;

CMFrata-rata = Average CMF value.

Cost Model Factor is average ratio model estimation cost to the actual cost. The accuracy is in percentage between the predicted cost and the real cost, the result of this equation is an absolute value that always has possitive value (Poh & Horner, 1995):

$$\text{Accuracy} = \left|\frac{(Ev-Av)}{Av}\right| x100\% \quad (3)$$

Description :

Ev = *Estimated Bill Value* (CSM project cost estimation);

Av = *Actual Bill Value* (HPS cost actual);

The American National Standars Institute (ANSI) in1991 (quoted from Kenneth, 2005), there are three (3)measuresof cost accuracy level that can be shown in Table 1 of accuracy level measure following

Table 1: Accuracy Level Measures

No	Measure	Cost Accuracy
1.	Cost Estimation	-30% to +50%
2.	Budget Estimation	-15% to +30%
3.	Definitive Estimation	5% to +25%
Source : Kenneth (2005)		

Rehabilitation and Irrigation Network Improvement: In Government Regulation (PP) Number. 20 of 2006 mentioned that the irrigation definition is the service to supply, manage, and drain the irrigation water to support the agriculture sector includingsurface irrigation, marsh irrigation, underground water irrigation, pump irrigation, and pond irrigation. The irrigation system consists of irrigation infrastructure, irrigationwater, irrigation management, irrigation management institutions, and human resources.

RESEARCH METHODOLOGY

Data Source: From the investigation done by Irrigation Institution ofSouth East Districtshows that there are 83 irrigation areas spread in 15 sub districts with the total areas are less than a thousand hectares (≤ 1000 Ha). The number of the work packages in the time period of the year arethirty one (31) work packages with the following details:

- 2011 Budgeting Year : 9 work packages
- 2012 Budgeting Year : 8work packages
- 2013 Budgeting Year : 7work packages
- 2014 Budgeting Year : 7work packages

Research Variable: The relation between independent variable and dependent variable can be illustrated in the following research model:

X_1 = Preparation item cost;	X_7 = Other item cost;
X_2 = Excavation itemcost;	X_8 = Water gate item cost;
X_3 = Barrow item cost;	X_9 = Drainhole item cost;
X_4 = Stone masonry item cost;	X_{10} = Gabion item cost;
X_5 = Stucco item cost;	Y = Amount of item value (real cost)

X_6 = Reinforced concrete item cost;	from all work items.

RESEARCH RESULTS

Work cost proportion can be shown in the following figure:

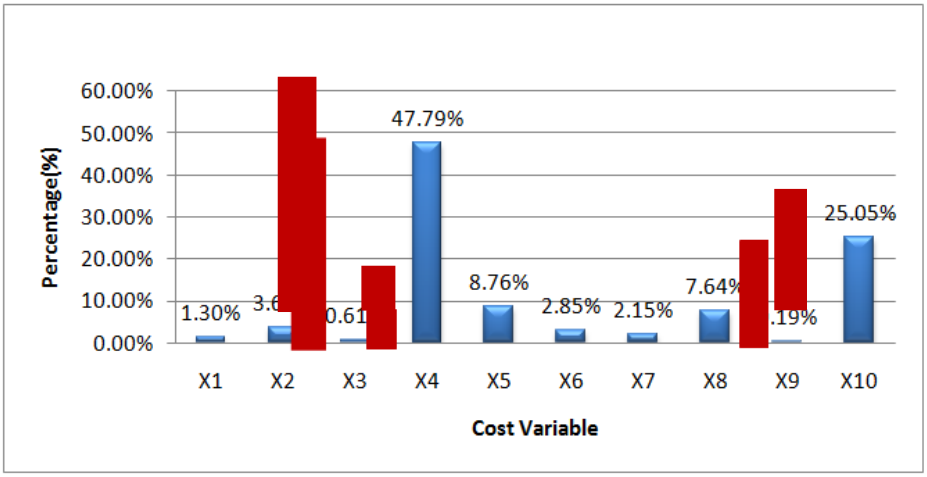

Figure 1: Work Cost Proportion Per $M^3$for The Stone Masonry

Cost Significant Items Determination*:* Future Value calculation result is shown in the following table:

Table2: Cost Significant Items Data Input

No	(Y)	(X_4)	(X_5)	(X_{10})
1	977,696	781.708	130,646	0
2	986,874	783,623	124,071	16,175
3	1,112,294	781,708	228,631	0
4	1,031,490	781,708	85,723	0
5	1,137,504	781,708	120,089	0
6	1,006,579	781,708	116,394	0
7	983,325	781,708	130,646	0
8	1,173,190	781,708	137,557	0
9	1,280,123	781,708	138,197	72,804
10	1,435,003	907,925	220,491	30,458
11	2,893,359	907,925	80,724	1,032,481
12	1,463,849	907,925	243,908	0
13	1,985,737	907,925	88,528	663,827
14	1,448,425	907,925	231,836	0
15	1,776,815	907,925	159,773	193,092
16	1,983,790	907,925	159,773	506,868
17	2,568,191	907,925	113,714	253,683
18	5,552,978	982,391	147,199	4,210,871
19	1,234,208	982,391	172,351	0
20	1,432,236	982,391	159,999	0
21	1,244,512	982,391	149,968	0
22	5,684,899	982,391	111,704	3,454,446
23	1,257,817	915,470	132,809	0
24	3,193,788	915,470	155,878	1,824,838
25	1,419,059	888,382	222,786	0
26	2,490,621	888,382	277,549	845,301
27	1,478,853	888,382	228,755	0
Table 2: Contd.,				

28	2,023,144	888,382	131,331	745,905
29	1,420,322	888,382	226,122	0
30	1,807,665	888,382	141,671	440,030
31	1,559,342	888,382	226,122	0

Normality Test: Normality test is done in data testing using Kolmogorov-Smirnov test. Kolmogorov-Smirnov test result shows that four variables tested had qualified normality test requirement with the probability or significance is bigger than 0.05 ($p \geq 0.05$).

DISCUSIONS

The correlation between X_4 variable and Y variable is 0.544; its meaning that the relationship between (Y) and X_4 is strong and positively correlated, meaning that the increase and decrease of the stone masonry work cost value X_4 will be followed by an increase or decrease of the (Y) cost, with the significant value is $0.002 \leq 0.05$, indicating that the gabion work cost affects the total cost in 95% of confidence level .

The correlation between X_5 variable and Y variable is (-0.153); its meaning that the relationship between (Y) and X_5 is weak and negatively correlated, meaning that the increase and decrease of the stucco work cost value X_5 will not be followed by an increase or decrease of the (Y) cost, with the p significant value is $0.411 \geq 0.05$, indicating that the stucco work cost does not affect the total cost.

The correlation between X_{10} variable and Y variable is 0.967; its meaning that the relationship between (Y) and X_5 is very strong and positively correlated, meaning that the increase and decrease of the gabion work cost value X_{10} will be followed by an increase or decrease of the (Y) cost, with the Sig significant value is 0.00 of$\leq$ 0.05, indicating that the gabion work cost affects the total cost.

It can be summarized that the relation between $X_{10}$and Y has very strong and possitively correlated relations, with the Sig significant value is 0.00 of ≤ 0.05, from the requirement shows that X_{10} gabion work cost significantly affects (Y) cost in 95% of of confidence level; followed by $X_4$and X_5.

Multiple Linear Regression Model X to Y: The determination coefficient (R^2) which is formed whole is to see the affect of all appropriateX variables according with Cost Significant Items value to Y variable, the results is obtained that $R^2$is 0.992. This shows that 99.20% work total cost is affected by of stone masonry work cost, stucco workcost and gabion work cost. While the remaining that is 0.80% is affected by other reasons. The standard error of the estimate isRp. 205.045 <standard deviation that is Rp. 1,156,557. The regression equation obtained is $Y = 1.49X_4 + 1.08X_{10}$

Testing Model: Table 3 shows that cost comparison of estimation cost model equations result per m^3 of stone masonry to the HPS actual cost per m^3 cubic of masonry based on Future Value calculation is obtained that the CMF average value is 1.017 with Y_{model} total cost is Rp. 54,475,014/m^3 and $Y_{HPS}$is Rp. 54,475,498/m^3.

Table 3: Result Summary of Cost Model Factor Calculation

No	X_4 (Rp/m^3)	X_{10} (Rp/m^3)	Y_{Model} (Rp/m^3)	Y_{HPS} (Rp/m^3)	*CMF*
1	781,708	-	1,164,745	977,696	1.191
2	783,623	16,175	1,185,068	986,874	1.201
3	781,708	-	1,164,745	1,112,294	1.047
4	781,708	-	1,164,745	1,031,490	1.129
Table 3: Contd.,					

5	781,708	-	1,164,745	1,137,504	1.024
6	781,708	-	1,164,745	1,006,579	1.157
7	781,708	-	1,164,745	983,325	1.184
8	781,708	-	1,164,745	1,173,190	0.993
9	781,708	72,804	1,243,372	1,280,123	0.971
10	907,925	30,458	1,385,703	1,435,003	0.966
11	907,925	1,032,481	2,467,887	2,893,359	0.853
12	907,925	-	1,352,808	1,463,849	0.924
13	907,925	663,827	2,069,742	1,985,737	1.042
14	907,925	-	1,352,808	1,448,425	0.934
15	907,925	193,092	1,561,348	1,776,815	0.879
16	907,925	506,868	1,900,225	1,983,790	0.958
17	982,391	4,210,871	6,011,503	5,552,978	1.083
18	982,391	-	1,463,762	1,234,208	1.186
19	982,391	-	1,463,762	1,432,236	1.022
20	982,391	-	1,463,762	1,244,512	1.176
21	982,391	3,454,446	5,194,564	5,684,899	0.914
22	915,470	-	1,364,050	1,257,817	1.084
23	915,470	1,824,838	3,334,875	3,193,788	1.044
24	888,382	-	1,323,689	1,419,059	0.933
25	888,382	845,301	2,236,614	2,490,621	0.898
26	888,382	-	1,323,689	1,478,853	0.895
27	888,382	745,905	2,129,267	2,023,144	1.052
28	888,382	-	1,323,689	1,420,322	0.932
29	888,382	440,030	1,798,921	1,807,665	0.995
30	888,382	-	1,323,689	1,559,342	0.849
		Y =	54,475,014	54,475,498	

In general, the Figure 2 shows that the description of the cost ratio from 2011 to 2014 is fluctuated and it is also obtained some following matters:

- The work packages that include in the range (-15%) up to (+ 30%) are twenty eight (28) packages;
- The work packages that include in the range (-15%) up to (+ 30%) are two (2) packages;
- From thirly (30) work packages of percentages, there are twenty eight (28) work packages that are good accuracy of 93.33% from the total packages, the two (2) packages remaining or 6.67% are not good accuracy, it means that CSM method generally results the good accuracy level of the budget planning;
- CSM cost estimation accuracy is in the range of(-11.72%) to31.31%, with the accuracy level average is7.18%;
- Cost comparation among CSM is Rp. 9,786,603,658; with the HPS actual cost is 9,153,036,967; with the price difference is 1.068% and accuracy level is 6.92% states that CSM cost estimation is bigger that actual cost of HPS calculation.

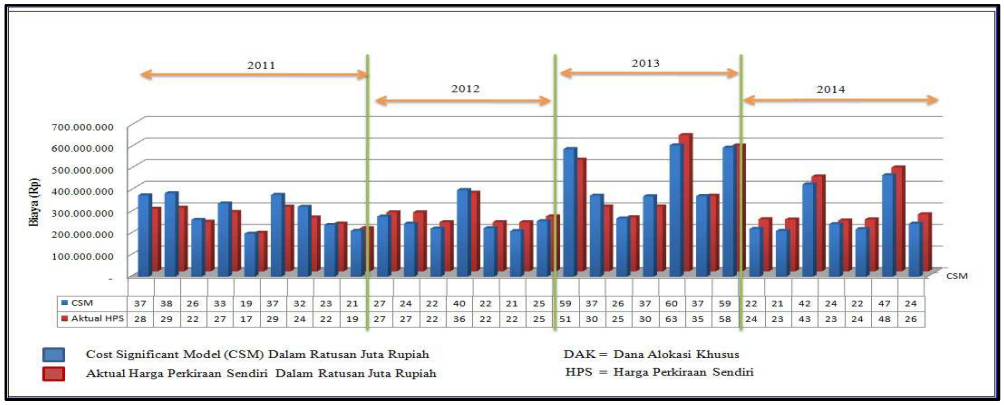

Figure 2. Comparation Graph betweenCost Significant Model and HPS Actual Cost

CONCLUSIONS

The works significantly affect the budget planning in rehabilitation and Irrigation network improvement projectof Irrigation Institution in South East Districtare stone masonry work (X_4) and gabion work (X_{10}), with the amount influence on Y of each are (X_4) = 74.90% and (X_{10}) = 69.50%. Thus the stone masonry work (X_4) becomes the most affected to budget planning in rehabilitation and Irrigation network improvement project of Irrigation Institution in South East District.

Multiple Linear Regression Modelcreated rehabilitation and Irrigation network improvement project of Irrigation Institution in South East Districtis $Y = 1.49X_4 + 1.08X_{10}$. CSM cost estimation accuracy level is in the range (-11.72%) to31.31%, and the average accuracy level is7.18%.

The cost comparison between Cost Significant Model is Rp. 9,786,603,658 and HPS actual cost is 9,153,036,967; the difference between CSM and the actual cost HPS is Rp. 633,566,690 (1.07%); and the accuracy level is 6.92%; stated that CSM cost estimation is bigger than HPS actual cost calculation, the meaning is the HPS estimation cost calculation is better than the CSM, but on the precision and accuracy, for policy makers to make decisions, CSM Method is more effective especially in rehabilitation and irrigation networks improvement project.

The results obtained are expected to be a control for policy makers in estimating cost budget planning in the next year period, so that the decision makers can take quick and accurate decisions, especially in rehabilitation and Irrigation network improvement project of Irrigation Institution in South East District.

REFERENCES

1. *DirjenPrasaranadanSaranaKementrianPertanian,"PedomanTeknisPengembanganJaringanIrigasi,Direktorat Pengelolaan Air Irigasi, 2014, Jakarta.*
2. *Project Management Institute, "A Guide To The Project Management Body Of Knowledge (PMBOK Guide)" – Fourth Edition, 2008, Newtown Square, PA 19073-3299 USA.*
3. *Istimawan, D.,"ManajemenProyekdanKonstruksi",Jilid 2, 1996, Kanisius, Yogyakarta.*
4. *Pemayun, I. D. G. A.,PraktekEstimasiBiayaDenganMetode Cost Significant Model PadaBangunanGedung Yang MemakaiArsitektur Bali (Tesis Magister, UniversitasAtma Jaya Yogyakarta, 2013).*

5. *Indrawan, I. G. S., EstimasiBiayaPemeliharaanJalandengan Cost Significant Model StudiKasusPemeliharaanJalanKabupaten di KabupatenJembrana (Tesis Magister, UniversitasUdayana Denpasar Bali, 2011).*
6. *Poh, P. S. H.& Horner, R. M. W., "Cost Significant Modelling-Its Potential for Use in South-East Asia, Paper in Engineering, Costruction and Architectural Management. 1995.*
7. *Ostward, P. F., "Construction Cost Analysis and Estimating", 2001, Prenctice Hall, New Jersey.*
8. *Kenneth, K. H., "Project and Cost Engineers' Handbook", Fourth Edition, North Carolina, USA, 2005.*